Timebase Sampling Modes

Depending on the timebase, any of three sampling modes can be chosen: Single-Shot, Random Interleaved Sampling (RIS) or Roll Mode. Furthermore, for timebases suitable for either Single-Shot or Roll Mode, the acquisition memory can be subdivided into user-defined segments to give Sequence Mode. Channels can also be combined to boost sample rate and record length.

Single-Shot

Single-Shot is the digital oscilloscope's basic acquisition technique and other timebase modes make use it.

An acquired waveform consists of a series of measured voltage values sampled at a uniform rate on the input signal. The acquisition, a single series of measured data values associated with one trigger event, is typically stopped at a fixed time after the arrival of the event, this being determined by the trigger delay. The time of the trigger event is measured using the timebase clock. The horizontal position of a waveform is determined using the trigger event as the definition of time zero. Waveform display is also carried out using this definition.

Because each channel has its own ADC, the voltage on each input channel is sampled and measured at the same instant. This allows very reliable time measurements between different channels.

Trigger delay can be selected anywhere within a range that allows the waveform to be sampled from well before the trigger event up to the moment it occurs (100 % pre-trigger), or at the equivalent of 10 000 divisions (at the current time/div) after the trigger.

For fast timebase settings the ADCs' maximum single-shot sampling rate is used (on one and each channel, with higher sampling rates achieved by combining channels — *see page 7–4*). For slower timebases, the sampling rate is decreased and the number of data samples maintained. (*See Appendix A for details*).

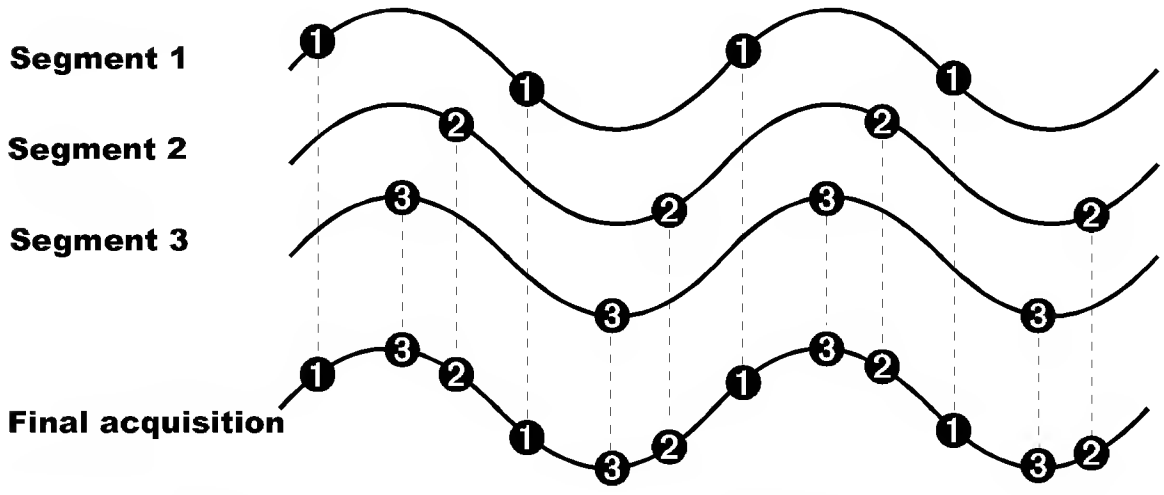
Peak Detect
NOT AVAILABLE WITH 9304C, 9310C, 9314C SERIES

When using slow timebases, sample-rate decreases and very short events such as glitches can be missed if they occur between two samples. To prevent this, a special circuitry called the Peak Detect system can be switched on (*see "Channel Use" menu, page 7–5*) to capture the signal envelope with a resolution of 2.5 ns. This is done without destroying the underlying, simultaneously captured data, on which a wide range of advanced processing can be performed.

RIS: Random Interleaved Sampling

RIS is an acquisition technique that allows effective sampling rates higher than the maximum single-shot sampling rate. It is used on repetitive waveforms with a stable trigger.

The maximum effective sampling rate of 10 GS/s can be achieved by acquiring 100 single-shot acquisitions, or bins, at 100 MS/s using the 9304C, 9310C, 9314C Series oscilloscopes; 20 bins at 500 MS/s when using the other models. These bins are positioned approximately 0.1 ns apart. The process of acquiring this number of bins and satisfying the time constraint is random. The relative time between ADC sampling instants and the event trigger provides the necessary variation, measured by the timebase to 10 ps accuracy.



On average, 104 trigger events are needed to complete an acquisition. But sometimes many more are needed. These segments are interleaved to provide a waveform covering a time interval that is a multiple of the maximum single-shot sampling rate. However, the real-time interval over which the waveform data are collected is orders of magnitude longer and depends on the trigger rate and the desired level of interleaving. The oscilloscope is capable of acquiring approximately 40 000 RIS segments per second.

Roll

Single-shot acquisitions at timebase settings slower than 0.5 s/div (10 s/div for traces with more than 50 000 points) have a sufficiently low data rate to allow the display of the incoming points in real time. The oscilloscope shows the incoming data continuously, "rolling" it across the screen, until a trigger event is detected and the acquisition completed. The latest data is used to update the trace display in the same manner as a strip-chart recorder. Waveform Math and Parameter calculations are done on the completed waveforms.

***Note:** The behavior of STOP, AUTO, NORM and SNGL is modified in Roll Mode and Sequence Modes (refer to previous chapter and pages 7–8 and 7–9).*

Sequence

Sequence Mode is an alternative to single-shot acquisition that offers many unique features. The complete waveform consists of a number of fixed-size segments acquired in Single-Shot Mode (*see Appendix A for the limits*), which are able to be selected. .

The dead time between the trigger events for consecutive segments can be kept to under 50 µs — in contrast to the hundreds of milliseconds normally found between consecutive single-shot waveforms. Complicated sequences of events covering a large time interval can be captured in fine detail,

***Note:** to ensure low deadtime between segments, button-pushing and knob-turning is to be avoided during sequence acquisition.*

ignoring uninteresting periods between events. And time measurements can be made between events on different

segments of a sequence waveform using the full precision of the acquisition timebase.

Trigger-time stamps are given for each of the segments in the "Text & Times Status" menu. Each individual segment can be displayed by Zoom, or used as input to the MATH functions. Sequence Mode can be used in remote operation to take full advantage of the scope's high data-transmission capability: overlapping transmission of one waveform with its successor's acquisition (*see the Remote Control Manual for details*).

The timebase setting in Sequence Mode is used to determine the acquisition duration of each segment, which will be 10 x TIME/DIV.

Timebase setting, desired number of segments, maximum segment length and total available memory are used to determine the actual number of samples/segment and time/point. The display of the complete waveform with all its segments may not entirely fill the screen.

Sequence Mode is normally for acquiring the desired number of segments and terminating the waveform acquisition. It can also be used to acquire the segments continuously, overwriting the oldest ones as needed, with a manual STOP order or timeout condition being used to terminate the waveform acquisition.

Combining Channels
NOT AVAILABLE WITH 9304C, 9310C, 9314C SERIES

The ADCs can be interleaved to boost standard sampling rate and record length considerably.

When channels are combined on two-channel models, both channels are paired on Channel 2, while Channel 1 is disabled. On four-channel models, the two pairs of channels are enabled on Channels 2 and 3, while Channels 1 and 4 are disabled. Both maximum sampling rate and record length are doubled using this function, activated by menu selection (*see page 7–8*).

On fast timebases it is even possible to again double the sampling rate by means of a special adapter. With this adapter in place, the oscilloscope interleaves the four ADCs and the acquisition memory to achieve the maximum sampling rate and up to four times the initial record length (*see Appendix A for details*).

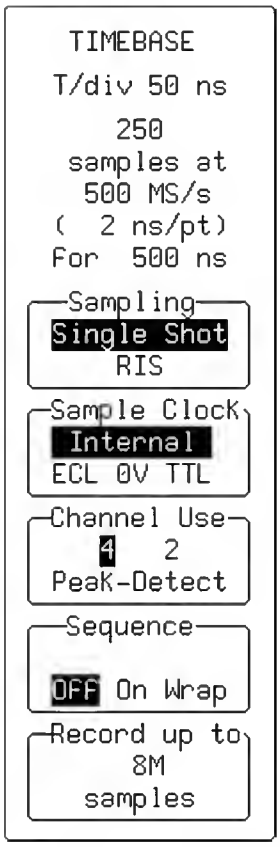
Timebase Setup

TIMEBASE

Press TIMEBASE SETUP to access and choose:

- **Single-Shot or Interleaved (RIS) sampling**
- **External clock**
- **Channel pairing (combining) and Peak Detect** ..
- **Sequence Mode**
- **Number of segments in Sequence Mode**
- **Maximum record length.**

The "TIMEBASE" menus also show the number of points acquired, the sampling rate and the total time span.



Sampling

For selecting either of the two principal modes of acquisition:

- "**Single Shot**" — displays data collected during successive single-shot acquisitions from the input channels. This mode allows the capture of non-recurring or very low repetition-rate events simultaneously on all input channels.
- "**RIS**" (Random Interleaved Sampling) — achieves a higher effective sampling rate than Single-Shot, provided the input signal is repetitive and the trigger stable.

Sample Clock

To select "**Internal**" or External ("**ECL**", "**0V**", "**TTL**") clock modes (*see next page*).

Channel Use (NOT AVAILABLE WITH 9304C, 9310C, 9314C SERIES)

To select for channel pairing and, on models with this feature, to control Peak Detect Mode (*refer page 7–2*).

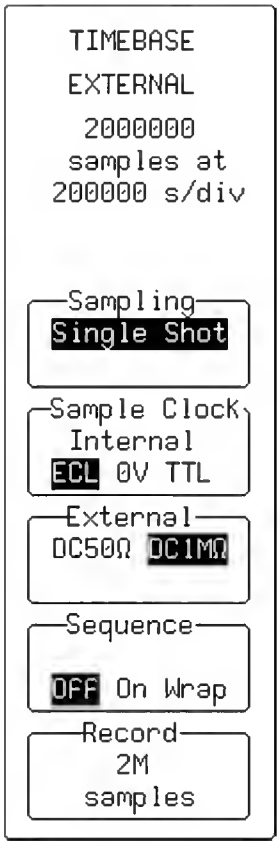
Sequence

For turning "**Off**" or selecting "**Sequence**" or "**Wrap**" Mode. *See page 7–9.*

Record up to

For selecting the maximum number of samples to be acquired, using the associated menu knob. *See Appendix A for model maximums.*

TIMEBASE EXTERNAL — appears when an External clock mode is chosen.



Sampling

This menu is inactive when the external sample clock is being used. Only single-shot acquisition is available (*see below*).

Sample Clock

For selecting a description of the signal applied to the EXT BNC connector for the sample clock up to 100 MHz. The rising edge of the signal is used to clock the ADCs of the oscilloscope. The effective thresholds for sampling the input are*:

ECL	–1.3 V
0V	0.0 V
TTL	+1.5 V

(With CKTRIG Option ONLY) RP (Rear Panel) specifies that the 50–500 MHz external clock connected to the rear panel be used as the sample clock (*see* CKTRIG Manual *for details*).

External

To select the input coupling for the external clock signal.

Sequence

Offers Sequence Mode. The corresponding knob is used to adjust the number of segments. Neither the trigger time stamps nor the AUTO sequence time-out feature are available when the external clock is in use. Nor is the inter-segment dead time guaranteed.

Record

To select the desired number of samples for the single-shot acquisition. *See Appendix A for model maximums.*

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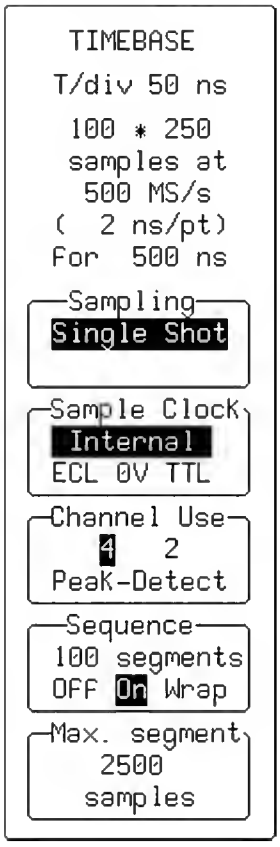
* External clock modes are available only if the EXT trigger is not the trigger source.

Notes for using External Clock

- *The time/div is expressed in s/div, to be understood to be samples/div.*
- *The trigger delay is also expressed in samples and can be adjusted as normal.*
- *No attempt is made to measure the time difference between the trigger and the external clock. Therefore, successive acquisitions of the same signal can appear to jitter on the screen.*
- *The oscilloscope will require a number of pulses (typically 50) before it recognizes the external clock signal. The acquisition is halted only when the trigger conditions have been satisfied and the appropriate number of data points have been accumulated.*
- *Any adjustment to the time/division knob automatically returns the oscilloscope to normal (internal) clock operation.*

TIMEBASE — Sequence — for operating in Sequence Mode



Sampling

This menu is inactive when the external sample clock is being used. Only single-shot acquisition is available (*see pages 7–6, 7–1*).

Sample Clock

For selecting a description of the signal applied to the EXT BNC connector for the sample clock (*7–6*).

Channel Use (NOT AVAILABLE WITH 9304C, 9310C, 9314C SERIES)

For combining or pairing channels to achieve more memory and a greater sampling rate by interleaving the ADCs in time. When "**2**" is selected on two-channel models both channels are combined, or paired. While when the same selection is made on four-channel models either Channels 1 and 2 or 3 and 4 may be combined. But when "**1**" on two-channel models or "**4**" on four-channel scopes is selected, none of the channels is combined.

Sequence

When either "**On**" or "**Wrap**" are activated, the menu changes to the one shown here. The associated menu knob is used to choose the desired number of segments, here given in example as "100 segments"..

Also, when "Sequence" is "**On**":

If the trigger mode is Single SNGL the oscilloscope fills the segments and stops.

But it will wait until STOP is pressed if there are not enough trigger events to fill the segments.

If the trigger mode is Normal NORM the oscilloscope fills the segments and then, if more trigger events occur, the acquisition is restarted from Segment 1.

If the trigger mode is Auto AUTO and if the time between two consecutive triggers exceeds a time-out that can be selected, the acquisition is restarted from Segment 1. The time-out is selected in "SPECIAL MODES" "UTILITIES".

However, when "**Wrap**" is selected, the segments are filled continuously until the STOP button is pressed. The last *n* segments will be displayed. An alternative way to stop the WRAP sequence is through AUTO mode; if the time between two consecutive triggers exceeds a time-out that can be selected, the acquisition will stop.

Max. segment

To select using the corresponding button or associated knob the maximum record length for each segment. *See Appendix A for model maximums.*

***Note:** A summary of the acquisition conditions is displayed above the "TIMEBASE" menus, indicating number of segments, available record length per segment, sampling rate, and timebase setting.*